

FINAL REPORT FOR NASA GRANT NAG5-9022 ("UNIVERSITY OF WASHINGTON PARTICIPATION IN SAFARI 2000") FOR THE PERIOD 15 FEBRUARY 2000 THROUGH 14 FEBRUARY 2005. PRINCIPAL INVESTIGATOR: PETER V. HOBBS, UNIVERSITY OF WASHINGTON

SUMMARY OF ACTIVITIES

The four Annual Reports submitted previously describe in some detail work carried out under this grant. In summary, we:

1. Prepared the University of Washington (UW) Convair-580 research aircraft for participation in SAFARI-2000 field study in southern Africa.
2. Participated in the 6-week field study in southern Africa. During the field study we flew 119.02 research hours (31 research flights). In these flights we obtained many unique data sets for evaluating the effects of biomass burning and other sources of particles and gases on the climate of southern Africa, and we obtained simultaneous measurements with NASA ER-2 and Terra overflights.
3. Quality checked the data obtained in SAFARI-2000, and archived it in the Oak Ridge National Laboratory DAAC.
4. Analyzed portions of the large data sets acquired in SAFARI-2000.
5. Attended several SAFARI-2000 workshops.
6. Attended national and international conferences to present SAFARI-2000 results.
7. Prepared thirty-four papers for publication and presentation at conferences.
8. Interacted with non-UW scientists in SAFARI-2000 studies, leading to many joint publications (25 out of 34 papers).
9. Supervised graduate students: Parikhit (Ricky) Sinha received his Ph.D. in 2004 for SAFARI research. His dissertation was entitled *Emissions from Savanna Fires in Southern Africa*. Louise Leahy is in her third year as a graduate student; her M.S. research is concerned with a comparison of in situ and remote sensing measurements of aerosol single-scattering albedo over southern Africa during the SAFARI field study. Brian Magi is basing his Ph.D. dissertation (*Estimating the Radiative Effects of Southern African Biomass Burning Aerosols*) on SAFARI-2000 data. This dissertation should be completed in the summer of 2005.

PUBLICATIONS

To complete this summary for NASA on the work carried out under this grant, it remains only to list the published papers. This is done below.

Publications and Conference Papers Since Last Report

1. Trentmann, J., T. Winterrath, S. A. Mason, T. J. Christian, R. J. Yokelson, M. O. Andreae, and P. V. Hobbs, "Comparing measurements and chemical model simulations of smoke plumes from an African savanna and an Alaskan boreal fire." Presented at AGU Fall Meeting, San Francisco, December 2003.
2. Trentmann, J., R. J. Yokelson, P. V. Hobbs, T. Winterrath, T. J. Christian, M. O. Andreae, and S. A. Mason, "Chemical processes in the smoke plume from a savanna fire." Presented at AGU Fall Meeting, San Francisco, December 2004.
3. Korontzi, S., D. E. Ward, R. A. Susott, R. J. Yokelson, C. O. Justice, P. V. Hobbs, E. A. H. Smithwick, and W. M. Hao, "Seasonal variation and ecosystem dependence of emission factors for selected trace gases and PM_{2.5} for southern African savanna fires," J. Geophys. Res., **108**(D24), 4758, doi:10.1029/2003JD003730, 2003.
4. Tabazadeh, A., R. J. Yokelson, H. B. Singh, P. V. Hobbs, J. H. Crawford, and L. T. Iraci, "Heterogeneous chemistry involving methanol in tropospheric clouds," Geophys. Res. Lett., **31**, L06114, doi:10.1029/2003GL018775, 2004.
5. Pósfai, M., A. Gelencsér, R. Simonics, K. Arató, J. Li, P. V. Hobbs, and P. R. Buseck, "Atmospheric tar balls: Particles from biomass and biofuel burning," J. Geophys. Res., **109**, D06213, doi:10.1029/2003JD004169, 2004.
6. Sinha, P., P. V. Hobbs, R. J. Yokelson, D. R. Blake, S. Gao, and T. W. Kirchstetter, "Emissions from miombo woodland and dambo grassland savanna fires," J. Geophys. Res., **109**, D11305, doi:10.1029/2004JD004521, 2004.
7. Sinha, P., L. Jaeglé, P. V. Hobbs, and Q. Liang, "Transport of biomass burning emissions from southern Africa," J. Geophys. Res., **109**, D20204, doi:10.1029/2004JD005044, 2004.
8. Trentmann, J., R. J. Yokelson, P. V. Hobbs, T. Winterrath, T. J. Christian, M. O. Andreae, and S. A. Mason, "Do we understand the chemical processes in the smoke plume from a savanna fire?" J. Geophys. Res., doi:10.1029/2004JD005628, 2005. (Accepted)

Publications Noted in Previous Reports (Copies of abstracts are enclosed.)

1. Swap, R. J., H. J. Annegarn, J. T. Suttles, J. Haywood, M. C. Helmlinger, C. Hely, P. V. Hobbs, B. N. Holben, J. Ji, M. D. King, T. Landmann, W. Maenhaut, L. Otter, B. Pak, S. J. Piketh, S. Platnick, J. Privette, D. Roy, A. M. Thompson, D. Ward, and R. Yokelson, "The Southern African Regional Science Initiative (SAFARI 2000): Overview of the dry season field campaign," South Afr. J. Sci., **98**, 125, 2002.
2. Hobbs, P. V., "Clean air slots amid atmospheric pollution," Nature, **415**, 861, 2002.
3. Hobbs, P. V., "Clean air slots amid dense atmospheric pollution in southern Africa," J. Geophys. Res., **108**(D13), 8490, doi:10.1029/2002JD002156, 2003.
4. Hobbs, P. V., "Appendix A: An overview of the University of Washington's airborne measurements in the SAFARI 2000 field study in southern Africa," J. Geophys. Res., **108**(D13), 8487, doi:10.1029/2002JD002325. [Appendix within Sinha et al., "Emissions of Trace Gases and Particles From Savanna Fires in Southern Africa."]
5. Sinha, P., P. V. Hobbs, R. J. Yokelson, I. T. Bertschi, D. R. Blake, I. J. Simpson, S. Gao, T. W. Kirchstetter, and T. Novakov, "Emissions of trace gases and aerosols from savanna fires in southern Africa," J. Geophys. Res., **108**(D13), 8487, doi:10.1029/2002JD002325, 2003.
6. Hobbs, P. V., P. Sinha, R. J. Yokelson, T. J. Christian, D. R. Blake, S. Gao, T. W. Kirchstetter, T. Novakov, and P. Pilewskie, "Evolution of gases and particles from a savanna fire in South Africa," J. Geophys. Res., **108**(D13), 8485, doi:10.1029/2002JD002352, 2003.
7. Magi, B. I., and P. V. Hobbs, "Effects of humidity on aerosols in southern Africa during the biomass burning season," J. Geophys. Res., **108**(D13), 8495, doi:10.1029/2002JD002144, 2003.
8. Magi, B. I., P. V. Hobbs, B. Schmid, and J. Redemann, "Vertical profiles of light scattering, light absorption, and single scattering albedo during the dry, biomass burning season in southern Africa and comparisons of in situ and remote sensing measurements of aerosol optical depths," J. Geophys. Res., **108**(D13), 8504, doi:10.1029/2002JD002361, 2003.
9. Eatough, D. J., N. L. Eatough, Y. Pang, S. Sizemore, T. W. Kirchstetter, T. Novakov, and P. V. Hobbs, "Semi-volatile particulate organic material in southern Africa during SAFARI 2000," J. Geophys. Res., **108**(D13), 8479, doi:10.1029/2002JD002296, 2003.

10. Gao, S., D. A. Hegg, P. V. Hobbs, T. W. Kirchstetter, B. I. Magi, and M. Sadilek, "Water-soluble organic components in aerosols associated with savanna fires in southern Africa: Identification, evolution and distribution," J. Geophys. Res., 108(D13), 8491, doi:10.1029/2002JD002324, 2003.
11. Kirchstetter, T. W., T. Novakov, P. V. Hobbs, and B. Magi, "Airborne measurements of carbonaceous aerosols from biomass burning in southern Africa during the dry biomass burning season," J. Geophys. Res., 108(D13), 8476, doi:10.1029/2002JD002171, 2003.
12. Pósfai, M., R. Simonics, J. Li, P. V. Hobbs, and P. R. Buseck, "Individual aerosol particles from biomass burning in southern Africa: 1. Composition and size distributions of carbonaceous particles," J. Geophys. Res., 108(D13), 8483, doi:10.1029/2002JD002291, 2003.
13. Li, J., M. Pósfai, P. V. Hobbs, and P. R. Buseck, "Individual aerosol particles from biomass burning in southern Africa: 2. Composition and aging of inorganic particles," J. Geophys. Res., 108(D13), 8484, doi:10.1029/2002JD002310, 2003.
14. Yokelson, R. J., I. T. Bertschi, T. J. Christian, P. V. Hobbs, D. E. Ward, and W. M. Hao, "Trace gas measurements in nascent, aged, and cloud-processed smoke from African savanna fires by airborne Fourier transform infrared spectroscopy (AFTIR)," J. Geophys. Res., 108(D13), 8478, doi:10.1029/2002JD002322, 2003.
15. Pilewskie, P., J. Pommier, R. Bergstrom, W. Gore, S. Howard, M. Rabbette, B. Schmid, P. V. Hobbs, and S. C. Tsay, "Solar spectral radiative forcing during the Southern African Regional Science Initiative," J. Geophys. Res., 108(D13), 8486, doi:10.1029/2002JD002411, 2003.
16. Schmid, B., J. Redemann, P. B. Russell, P. V. Hobbs, D. L. Hlavka, M. J. McGill, B. N. Holben, E. J. Welton, J. R. Campbell, O. Torres, R. A. Kahn, D. J. Diner, M. C. Helmlinger, D. A. Chu, C. Robles-Gonzalez, and G. de Leeuw, "Coordinated airborne, spaceborne, and ground-based measurements of massive, thick aerosol layers during the dry season in southern Africa," J. Geophys. Res., 108(D13), 8496, doi:10.1029/2002JD002297, 2003.

17. McMillan, W. W., M. L. McCourt, H. E. Revercomb, R. O. Knuteson, T. J. Christian, B. G. Doddridge, P. V. Hobbs, J. V. Lukovich, P. C. Novelli, S. J. Piketh, L. Sparling, D. Stein, R. J. Swap, and R. J. Yokelson, "Tropospheric carbon monoxide measurements from the Scanning High-Resolution Interferometer Sounder on September 7, 2000 in southern Africa during SAFARI 2000," *J. Geophys. Res.*, **108**(D13), 8492, doi:10.1029/2002JD002335, 2003.
18. Sinha, P., P. V. Hobbs, R. J. Yokelson, T. J. Christian, T. W. Kirchstetter, and R. Bruinjtes, "Emissions of trace gases and particles from two ships in the southern Atlantic Ocean," *Atmos. Environ.*, **37**(15), 2139, 2003.
19. Sinha, P., P. V. Hobbs, R. J. Yokelson, D. R. Blake, S. Gao, and T. W. Kirchstetter, "Distribution of trace gases and aerosols during the biomass burning season in southern Africa," *J. Geophys. Res.*, **108**(D17), 4536, doi:10.1029/2003JD003691, 2003.
20. Kaufman, Y. J., J. M. Haywood, P. V. Hobbs, W. Hart, R. Kleidman, and B. Schmid, "Remote sensing of vertical distributions of smoke aerosol off the coast of Africa," *Geophys. Res. Lett.*, **30**, (16), 1831, doi:10.1029/2003GL017068, 2003.

Conference Papers Noted in Previous Reports

1. Hobbs, P. V., "Overview of measurements obtained aboard the University of Washington's Convair-580 research aircraft in SAFARI 2000 and some results." Presented at *NASA SAFARI 2000 Review and Planning Meeting*, NASA-GSFC, Maryland, May 2001.
2. Hobbs, P. V., "Overview of measurements obtained aboard the University of Washington's Convair-580 research aircraft in SAFARI 2000 and some preliminary results." Presented at *SAFARI 2000 First Data Workshop*, Siavonga, Zambia, August 2001.
3. Hobbs, P. V., "Overview of University of Washington's Airborne Studies in SAFARI 2000." Invited Paper presented at *Special Session on SAFARI 2000*, AGU Fall Meeting, San Francisco, December 2001.
4. Hobbs, P. V., "Particles on gas emissions from a savanna fire from biomass burning in southern Africa." Presented at *Special Session on SAFARI 2000*, AGU Fall Meeting, San Francisco, December 2001.

5. Magi, B., P. V. Hobbs, B. Schmid, and J. Redemann, "Vertical profiles of light-scattering, light absorption and single-scattering albedo during the dry biomass burning season in southern Africa and comparisons of in situ and remote sensing measurements of aerosol optical depths." Presented by P. V. Hobbs at *SAFARI 2000 Synthesis Workshop*, University of Virginia, Charlottesville, VA, October 2002.
6. Hobbs, P. V., P. Sinha, R. J. Yokelson, and T. J. Christian, "Emissions and evolution of trace gases and particles from savanna burning in southern Africa." Presented by P. V. Hobbs at *IAMAS/CACGP/IGAC Conference on "Atmospheric Chemistry in the Earth System: From Regional Pollution to Global Change"*, Crete, Greece, September 2002.
7. Hobbs, P. V., "Emissions from ships and their effects on the atmosphere." Invited paper at *8th International Conference on Atmospheric Sciences and Applications to Air Quality*, Tsukuba, Japan, March 2003.

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